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Analyzing GM Food Risk Arguments through an Online, Multi-media Case Study

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ABSTRACT: We constructed an online, multi-media simulation of an environmental debate, and analyzed the uses of scientific information from it that 41 college students included in arguments about the issue. Analysis of the ways students appropriate information to reason about science suggests they do so much as scientists do in public policy debates.

KEYWORDS: argument, case study, multi-modality, online, rhetoric of science, risk, teaching.

1. INTRODUCTION

Rhetorical studies of science have charted what Fahenstock (1986) calls the "rhetorical life of scientific facts" from laboratory through popular media. These studies have generally contradicted the "canonical view" (Myers, 2003) that states that popularization is simply a readable translation of the scientific research; instead there are ample evidence to show that science facts undergo various transformations in their rhetorical lives, and there exists a great deal of differences between scientific research and the popularized account (Charney, 2003; Fahnestock, 1986; Myers, 1991).

However, insufficient attention has been paid to examine a crucial further reinscription, and we know relatively little about how these popularized accounts of science are rhetorically taken up by various members of the public and policy makers. Studies that examined the uptake of popularized accounts so far have been generally limited to surveys that measure superficial knowledge of arbitrarily selected scientific information (e.g., Miller, 1998; Sturgis & Allum, 2004) and experimental studies that isolate scientific information from the naturally-occurring discourse and reinscribe it in an artificial experimental discourse.

Such studies provide useful information on potential behavior, but do not tell us much about why people value and devalue GM products or why they might change their views, in other words, the reasoning used—how decisions are made based on scientific information. In addition, the hypothetical questions and experimental auctions must greatly simplify the discourse as they frame the survey questions or prompts. Whereas for most people, scientific information comes integrated into (some would say buried in) a complex circulation of

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discourse from a range of stakeholders in various media and genres, which consumers or the public must take up in order to use of science for reasoning and/or decision-making. Lusk, Jamal, Kurlander, Roucan, & Taulman (2004) in "A Meta Analysis of Genetically Modified Food Valuation Studies" suggest that "areas for fruitful research lie in explaining *why* consumers have particular a valuation estimate."

This raises the problem we address in this research. How do people use scientific information to make arguments (reason) about the risks of GM foods? Policy makers and consumers alike assess the risks of and make decisions about GM foods based on both scientific/economic data and reasoning or *arguments* about that data that involve value judgments. Facts rarely speak for themselves in policy deliberations, even when the facts are not disputed. People may agree that certain foods contain certain substances at certain levels as established by scientific studies, but they may then *use* that information as part of chains of argument that justify increasing *or* lowering allowable levels, based on differing value judgments and chains of argument. Or they may accept certain scientific information and discount other scientific information in their arguments (and decisions) based on their reasoning and value judgments (including level of trust of the source of the scientific information).

In the past decade, a few researchers have attempted to get at the relationship between scientific information and values in risk decision making through rhetorical (argument) analyses of discourse used by various stakeholders in public deliberations on environmental policy (Cook, 2004), notably case studies of the discourse of particular deliberations. One problem such studies pose is that they are, of course, unrepeatable and limited to particular group of people, those participating in the particular public deliberations studied. Researchers cannot manipulate the situation to introduce different information or stakeholders/participants. To address this methodological problem we turned to an online multi-media case study, in hopes that it would allow us to model the complexities of discourse on a GMO policy issue and elicit discourse for more detailed analysis and larger numbers of participants than case studies of actual deliberations. Our research follows Macoubrie (2003) who constructed an online forum for public discussion of biotechnology policy to elicit arguments for analysis. We also analyze the *arguments* or reasoning people use when presented with a range of information in different media and are asked to make an argument to justify a policy decision.

2. METHODS

We adapted an online, multi-media case study to represent an environmental debate on Golden Rice (which Hessler first developed and used in an extension Biotechnology Ethics course). Golden Rice (GR) is a genetically modified food that contains higher levels of vitamin A. Its chief developer, Ingo Potrykus, argues that it can help prevent VAD, which causes 500,000 cases of blindness and contributes to over 1,000,000 deaths per year (VAD means a 25% greater risk of dying from measles, malaria, or diarrhea) and is the leading cause of blindness in children. But GR has been highly controversial. Proponents in the biotech industry have promoted it as a wonder cure for developing countries, the shining example of biotechnology's promise. Opponents among environmentalists have argued that it does not contain enough VA to address the problem, that it may cause environmental and economic harm, and that existing, effective VA supplement programs are capable of solving the problem and would be defunded to support what is, in their view, a "Trojan Horse" or "poster child" for multinational agriculture corporations.

The Golden Rice case models the complexities of the GR debate by providing textual and video information from pro-GR sources, anti-GR sources, and sources that do not explicitly take a stand. Roughly equal numbers of each were included. The sources that do not take a stand are grouped under "background." Those that take a stance are under "opinions," represented geographically, with no indication to the students whether each opinion was pro or con. In addition, there is a list of links to other information, listed thematically rather than by stance, (and again roughly balanced pro and con no position).

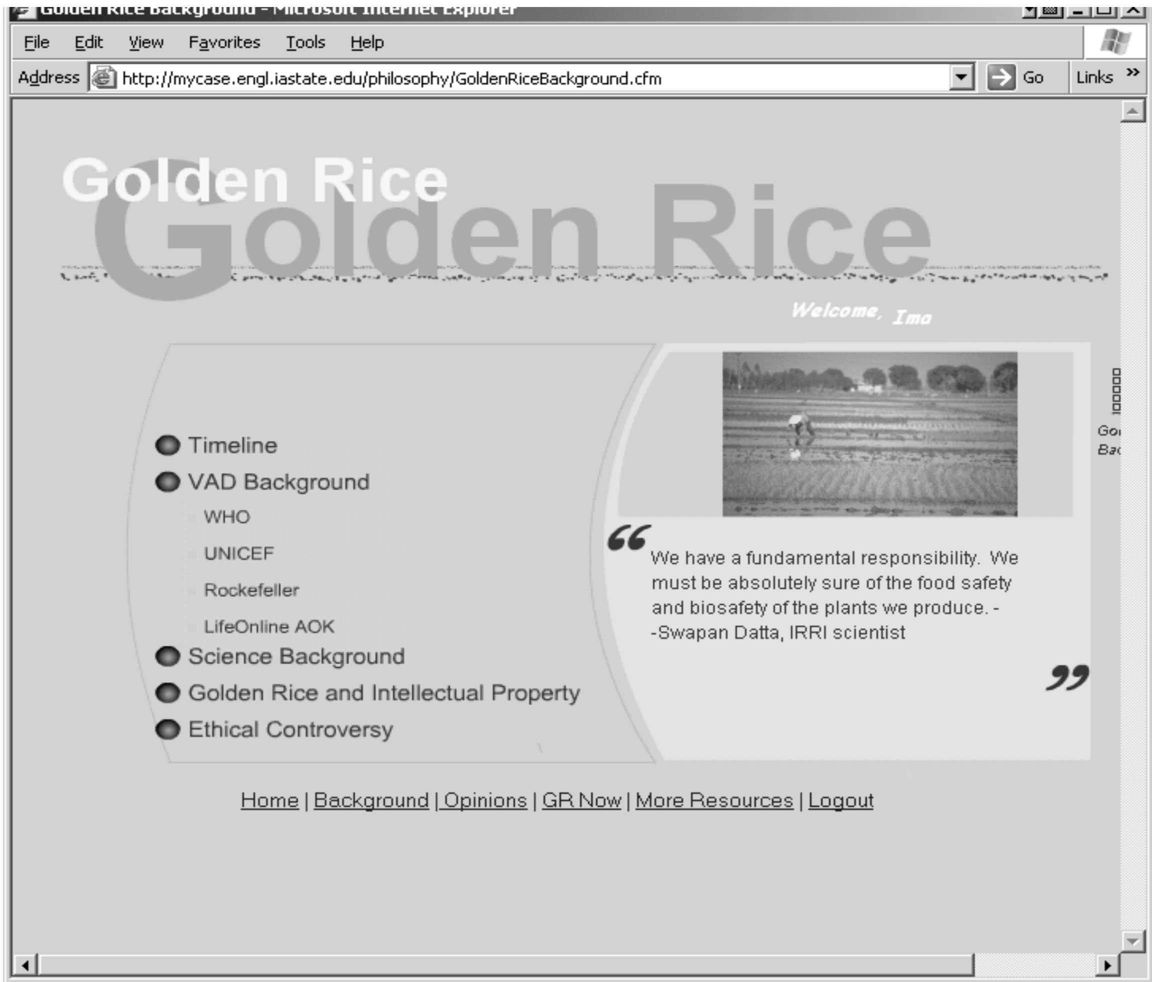

Fig. 1: The Golden Rice online case, main page

In a three week unit, students are given the assignment of writing a recommendation to the Rockefeller Foundation, the leading funder of Potrykus's GR research for over a decade, on the level of funding, if any, that Rockefeller should devote to GR research in the future. During the unit, students first (1) research the case and (2) discuss it in class and in threaded online discussions. As the instructor in the course, I did not intervene in the classroom or online discussions and did not, to the best of my ability, push them in any direction, pro, con, or in between. Finally, they (3) each make a decision about the level of funding and explain that decision in a written argument (about 1000 words), in a letter addressed to the Rockefeller Foundation.

The case was used in two sections of a first-year course in general academic writing, required of all students in a large Midwestern U.S. university of science and technology (N=41). The students represented ten majors (disciplinary curricula), with 10 in the natural sciences, 5 in agriculture, 13 in engineering, 8 in business, and 5 in humanities. Two were international students. This was a homogeneous group of mainly Midwestern U.S. students, in terms of sex, ethnicity, and age, close to the Midwestern University student population as a whole. No students had prior knowledge of Golden Rice, though five had knowledge of GMO crops, firsthand from their farming backgrounds.

Fig. 2: The Golden Rice online case, clickable world map showing one location

We gathered survey data and student texts for rhetorical analysis. We will give the survey methods and results first, then move to the textual analysis methods and results, and finally try to triangulate the two.

3. SURVEY METHODS AND RESULTS

We administered a 14-question pre-post survey (six point Likert scale) to measure the students' perception of their knowledge of genetic engineering and their attitudes toward biotechnology, which we adapted from one Hessler had used at a biotechnology conference.

Students' perception of their level of knowledge increased p = < .011 This is clearly what we would expect as they had just spent three weeks studying it.

Table 1. Survey Results

Question 1. Knowledge of Biotechnology: Summary Statistics

	N	Mean*	S.D.	*T*-Value	*P*-Value
Pre	39	2.72	1.19	-2.688	< .011
Post	39	3.18	1.00		

Questions 2-14. Attitudes toward Biotechnology: Summary Statistics

	N	Mean	S.D.	*T*-Value	*P*-Value
Pre	39	2.48	0.47	5.759	< .001
Post	39	2.15	0.42		

*N.B.: A lower experimental mean = anti-biotechnology

This might be explained by the treatment. Though we tried very hard to control for bias in the case and the pedagogy, we may not have succeeded. But this result is consistent with NSF national survey results, which show "a slight, gradual decline in the American public's support for genetic engineering between 1985 and 2001. The shift can be seen most clearly among college-educated respondents and those classified as attentive to science and technology issues." Huffman, Shogren, Rousu, & Tegene (2003) also found in their experimental auction research that "Participants who claimed to be informed about GM technology in pre-experiment survey were significantly more likely to be out of the market for GM products." We now turn to the qualitative data and our central question. Later we'll return to a more specific analysis of the pre/post survey results to triangulate the two.

4. RHETORICAL ANALYSIS METHODS AND RESULTS

Before we look at the methods and results of the qualitative, rhetorical analysis, we need a bit of theory. This study is based on argument theory and the rhetoric of science (a field about 25 years old).

The version of argument theory we are using suggests that people choose arguments and evidence from the rhetorical resources available, given the constraints of the context, on the basis of their usefulness in accomplishing their goals, not on the basis of some universal principles of rationality or correctness (Bazerman & Paradis, 1991). The fundamental unit of analysis for resources for argument is the topos (plural topoi), from the Greek for "places" (as in topography). Topoi are the common means of persuasion in some community or domain (Aristotle). And the topoi vary with the rhetorical context (or discipline or profession or legislative body, etc.) and the subject, as do the rules or norms for argument (Toulmin, 1979).

Studies over the past 20 years in the rhetoric of science have shown that scientists argue using two very different repertoires of rhetorical resources that scientists use in different social contexts, called the empiricist and the contingent repertoire (Gilbert & Mulkey, 1984?).

> The empiricist repertoire, found in research papers and other formal documents, is characterized by lexical and syntactical arrangements that convey the realist view of science, the ideology that scientists' practices are required by the nature of the physical world. In this [repetoire], scientists are depicted as conduits for the realization of natural phenomena, their own agency deleted. The contingent repertoire, on the other hand . . . is marked by the presence of accounts that attribute influences on behavior to factors external to the physical phenomena under investigation. (Janillo, 2004)

The contingent repertoire is utilized by scientists in their informal talk and—importantly for this study—in most public discussions of science when scientists are speaking as advocates.

EMPIRICIST REPETOIRE	CONTINGENT REPETOIRE
Experimental articles	Editorials, opinion pieces, hall talk, lab talk
Factors contingent on human agency disallowed in persuading colleagues	Factors contingent on human agency allowed to in persuading.
Closed community: experts only (Ph.d. in speciality + original data set required to speak)	More open community: non-experts allowed; no original data set
Data as agents: humans reduced to citations; data assumed to speak; passive voice	Humans as agents
Arguments constrained by methods and norms of field	Arguments open
No appeals to emotion	Appeals to emotion common
No impugning of motives	Impugning motives common
No name calling	Name calling common
Claims highly qualified and hedged	Claims less qualified and hedged (or not at all)

For example, here is Potrykus, the developer of GR in an interview: "If some people decide that they want blind children and white rice, the decision is theirs. I am offering the possibility of yellow rice and no blind children. But the decision about what people want to eat is theirs." This appeal to emotion (rather passive/aggressive at that) would of course never appear in an experimental article. It is not a simple choice between GR and blindness. There are many synthetic and natural supplements available and being used today around the world, as Potrykus is well aware. Rather it's a policy choice about what part if any GR could play in combating VAD, a very complex cost/benefit analysis that micro-biologists do not do. Economists and others do this. But in the absence of a full cost/benefit analysis we are left with arguments from the contingent repertoire.

Similarly, Greenpeace emotionally dramatized the central problem of GR with this photo with the caption: "The amount of Golden Rice that must be eaten every day to obtain the daily RDA of VA." Nine kilos a day. Potrykus experimentally established that current strains of GR provide 8-10% of the RDA and it would take nine kilos a day of GR for a person to get the US RDA of VA. But of course Potrykus argues that with further funding that level could be increased greatly, and furthermore, that the US RDA is "luxurious" and much smaller amounts of VA will prevent enough blindness and other diseases to justify the cost. In the complex circulation of discourse about GM policy, the contingent repertoire is what is useful and appropriate, for scientific experts as well as non-experts.

Fig. 3: Greenpeace photo

4.1 Rhetorical Analysis Methods

First we coded each of the sources and the students' letters pro/con/middle (IRR =.84). Then we located their use of scientific information in the papers. Because the students used so much scientific information in their arguments, we narrowed our analysis to the use of one form of quantitative information, percentages, which figured importantly in their arguments. Current strains of GR contain only about 8-10% of the RDA of VA. Thus students' arguments and decisions often turned on whether these relatively small amounts were enough to justify further research. We then traced each use of a percentage in the student letters to the source it came from. We coded the arguments in which students used a percentage from a source according to whether the student:

- Uses the *same* argument as source
- Cites source to *refute* it
- Uses the information as *evidence* for an argument *not made directly in source*
- Uses the information as *background* information
- Was *untraceable* (due to poor documentation)

With the help of a concordance program, we then looked at each use of "Percent" (in all its forms) to identify the topoi in that the students had used. We were guided by previous linguistic and rhetorical research on common topoi in the GM foods (Cook 2004).

4.2 Rhetorical Analysis Results and Discussion

Students clearly used scientific information to make their arguments. They used Percent 124 times, an average of three times per letter. All but two of the 41 letters used Percent and those two used other quantitative information. The supporters of GR research were no more likely to invoke Percentages than the opponents (47% pro, 49% con). We are now ready to move to our central question. How did these students use scientific information to make arguments (reason) about the risks of GM foods?

4.3.1 What Positions Did Students Take?

Though the assignment specifically invited students to explore middle positions, only two took a middle position. The rest almost exactly evenly divided between pro and con (20 pro, 19 con).

Recalling our theoretical premise that people choose arguments and evidence from the rhetorical resources available, given the constraints of the context, on the basis of their usefulness, one might explain this polarization as an effect of the students perceiving it as a school exercise in debate, like many others they may have encountered, where one is expected to take a clear stand. A second and compatible explanation is that the models available in the case (and in the wider discussions of GM foods) are very much polarized. Within the case materials, there were very few models for discourse that carefully weighed scientific evidence to reach a decision. There were journalistic or background information articles that presented "both sides" (but took no position explicitly). But the materials that took a position, whether from environmentalists, corporations, or—and perhaps most importantly—scientists from academic and humanitarian organizations, did not take a middle position. The closest we can come are the replies that Gordon Conway and Potrykus wrote to environmental activist organizations. There, given the constraints of talking to those who disagree, they produced arguments that conceded points, qualified their statements, and so on. But even in these letters, their positions were clearly and overwhelmingly pro.

4.3.2. How Did Students Use Scientific Information?

Because we focused on how the students used Percent to make arguments compared to how their sources used the same information, we did not focus on the 10 instances of Percent where the students used them as background information or the 15 instances where we could not track down their sources. This reduced the total instances of Percent from 124 to 99 and yielded the following results.

Table 2. Uses of percent information in student letters

	# OF USES (n=99)	# OF LETTERS (n=41)
Uses the *same* argument as the source makes using the Percent information	58	29
Cites source using Percent information to *refute* the source's argument	13	11
Uses the information as *evidence* for an argument not made directly in source	28	15
From source that *doesn't take a position* on GR	21	11
From source that *does not mention* Golden Rice	7	4

4.3.2.1 Same Argument as Source:

Students used scientific information in the form of percentages primarily by appropriating the same argument as the source that contained the percentage (58%). This is not surprising in one sense. If one means to persuade, then it is useful to have ready-made arguments, topoi. And in every raging debate there are topoi available, constructed by others who have thought about it and made good arguments, appropriated and shared among participants. We suggest as a hypothesis that in policy debates, students use scientific information as part of *argument units,* not as individual facts that speak "for themselves." This is also the way scientists primarily use scientific information, whether in experimental articles (the empiricist repertoire) or in private talk (hall talk) or in public debates (the contingent repertoire). Experimental articles are specifically built on the arguments other scientists have made. Each new experimental article tries to push slightly forward (or backward) the arguments other scientists have made ("concept simple as unit of experimental article in the sciences). Students mostly used scientific information not as background information (discrete facts, as science is often presented in textbooks) but rather as evidence for arguments, their goal.

The particular argument units (topoi) the students borrowed the most were also the most salient, the ones that the experts are using when they are most engaged with the problem: the problem of whether and to what extent and how soon Golden Rice could prevent VAD *in comparison to existing supplements.* The fact that the students used Percent arguments in the ways sources did suggests they were able to get at the heart of the issue (what argument theory calls the *stasis* point). These students were able to find the crux (stasis point) of the public policy debate. This suggests that other non-experts may also be able to as well (see Macoubrie, 2003).

In the absence of full economic risk-benefit analyses of the impacts of various supplementation programs, both experts and non-experts are in the same rhetorical boat. But it is nevertheless important for people, whether experts or non-experts, to appropriate and rehearse the argument units, the topoi, because this is how a person makes arguments one's own. When words come out of one's mouth, one become committed to them, though rarely finally. In addition, rehearsing others' arguments can affect one's attitudes (as the discussion below of the survey data will suggest).

The next results, Refutation and Evidence, are more interesting because they suggest ways that students transform the scientific information to make arguments, instead of merely appropriating an argument unit wholesale from a source.

4.3.2.2 Refutation

One way is to take information from a source that disagrees with one's own position in order to refute it. One has to engage with the arguments of the opposition. In 13% of the instances (11 students, six pro, four anti, 1 middle) students took an argument with a percentage from one of the sources and then refuted it. In the empiricist repertoire of experimental articles, scientists very rarely cite others to refute them, less than one percent of the time, according to Hyland (1999). One risks making enemies in a small community. But in the contingent repertoire—public discourse on science policy—the risks of refutation are not so great, and it is very useful in marking off the arguments to understand them for one's self and for persuading others.

All four of the anti-GR students who refuted employed the topos of risk/benefit. All four took the figure that GR currently contains 8-10% of RDA and argued that this is insufficient to justify the investment compared to synthetic and natural plant VA supplements. Five of the six pro-GR students took the 8-10% figure from the then-current research and used it to argue that it is sufficient as a supplement. In both cases, they are not debating the scientific figures. These are taken as agreed (both by the students and by their sources). The arguments concern the interpretation of the numbers, value judgments made without much data. In this, the students are doing what scientists do in public arguments, where the issue is not the results of empirical research, but the meaning of it for policy decisions. However, students engaged in relatively little of the name-calling and impugning of motives that is common among those debating GMO policy, including scientists. Only five students used such tactics: Here is one:

> Greenpeace . . . claims that Golden Rice provides at best 8%01.1 of the RDA of Vitamin A. He then says that an adult would need to eat nine kilos of cooked rice in order to receive their daily dose.[(7)] This is ridiculous because Golden Rice was never intended to fulfill the daily requirements of vitamin A; it was designed to be a supplement, nothing more. It is also a much better supplement than Greenpeace would have the public believe. A realistic estimation of the amount of Vitamin A Golden Rice imparts is around 10-20% of the RDA when the average 300g is ingested.[(3)] The lengths that opponents of Golden Rice will go to in order to prevent the spread of GMO's is outrageous. . . .

Compare Potrykus (2004), writing an editorial in a scientific journal *Plant Physiology*, presumably to a friendly audience:

> Thus, the opposition has argued that there is no need for "golden rice" because distribution of synthetic vitamin A works perfectly, or that nobody wants it because it tastes awful, or that people who eat "golden rice" will lose their hair and sexual potential! If you are interested in further misinformation of this kind, please consult various anti-GMO Web sites on the Internet. . . . In my judgment, hindering a person's access to life- or sight-saving food is criminal. To do this to millions of children is so criminal that it should not be tolerated by any society. . . . In my view, the Greenpeace management has but one real interest: to organize media-effective actions for fund raising. The "golden rice" case hopefully may help to unmask the true and shameful face of Greenpeace . . . (p. 23)

Perhaps students used so little of the invective common among experts because they were in a classroom context and worried the teacher would penalize them for it. Or perhaps they were not as invested in the outcome. But perhaps it was because they were arguing in a context in which they had to encounter those with different views directly, as Potrykus does when he is writing not for the relatively sympathetic audience of *Journal of Plant Physiology* readers, but a reply to Greenpeace (Potrykus, 2004).

4.3.2.3 Evidence

Perhaps the most interesting way students used scientific information beyond simply rehearsing the same argument as a source using the same information, was to take information from sources that did not take a stand. This occurred in 21% of the instances, and 11 of the 39 students did this (6 pro, 5 con) (pro 14 instances, con 13, middle 1). Students were synthesizing information. This is particularly interesting because it seems to be a way of using information from sources that don't take a stand in order to come to a decision.

The anti-GR students primarily used information from sources that did not take a stand in order to demonstrate that alternatives to GR are available. They cited studies of food fortified with VA, native (non-GMO) plants high in VA, and VA pill supplements.

> Research done by WHO found that high-dose supplements "produced remarkable results, reducing mortality by 23% overall and by up to 50% for acute measles sufferers." Supplements are effective and cost efficient. If the Rockefeller foundation is serious about fighting VAD they should start funding organizations who provide and distribute supplements.

The pro-GR students primarily used information from sources that did not take a stand to point out difficulties with supplements, in absorption, distribution, and so on.

> Vegetables, even though they contain high quantities of beta carotene, are actually poor sources of vitamin A because only two to four is actually absorbed. Fortification has been shown to be beneficial and costs a little more than the regular product. The problem with this method is that many poor populations do not buy processed foods, thus not receiving the vitamin A intended for them.

Four students used information from sources that did not mention GR, to draw analogies, a common topos in public policy arguments where there is little direct evidence (no field studies of environmental or economic effects). Two pro-GR students used studies of other GM crops to make a case by analogy: *bt* corn, soy, and cotton showed no adverse environmental effects (and positive economic effects); GR will do the same. An anti-GR student used statistics on the Green Revolution's impact on biodiversity to argue that GMO GR would do the same.

In citing information from sources that do not take a position, students were not making original arguments. They were doing what their sources that took a side did: finding evidence for pre-existing arguments that appeared more credible. But they were wrestling with the complexity of the arguments, pushing toward a deeper analysis of the issues, the sort of analysis that would be included in a complex risk-benefit analysis done by scientists (though not yet on GR).

5. TRIANGULATING SURVEY AND RHETORICAL ANALYSIS RESULTS

We now return to the survey results to suggest ways that the rhetorical analysis of arguments might speak to them. As noted earlier, the students' post-test responses showed a statistically significant move in the direction of anti-biotechnology. But when we examined the specific questions that showed statistically significant pre/post difference in light of the rhetorical analysis of their letters, we began to see the results not simply as a change in positions, but, perhaps, as a change of their understanding of the ways science is used to come to policy decisions. The five questions where the students' responses moved in the direction of anti-biotechnology were:

- #2. "Biotechnology is unnatural and should, therefore, be treated with great caution." $p = .005$
- #3. "Better scientific information on biotechnology will lead to greater acceptance of food produced with biotechnology." $p < .001$
- #10. "Technology can solve most of our most pressing human problems." $p = .033$
- #12. "Biotechnology could benefit millions of people." $p < .001$

- #14. "I am suspicious of scientific information on biotechnology that comes from environmental groups." p = .044

Even supporters of biotechnology GMO crops may well have felt, after reading, discussing, and making arguments on GR, that great caution is necessary; that better scientific information is not necessarily what determines acceptance; and that technology is not in itself a solution but must engage with a range of complex and contingent human factors—a rhetorical process. The students' discussions were experiential examples of the complexity and difficulty of arriving at consensus, acceptance, and solutions.

On one question the responses moved in the direction of what we thought, at least when we designed the survey, was pro-biotechnology (although the result is barely significant at the .05 level).

- #7. "We do not need full scientific certainty that biotechnology products are safe before biotechnology products are released." ***p = .046***

The question was intended to tease out attitudes against opponents of biotechnology that point to fears as a common topos. Yet here again, the change might suggest that their engagement with the complexities of policy debates made students less confident in the ability of scientific information to settle disputes in the face of the social and rhetoric complexity of coming to a decision, whether they were for or against biotechnology.

6. CONCLUSION

What have we found then about how non-experts use scientific information to make arguments (reason) about GM food issues? What happens when information from experimental articles (empiricist repertoire) enters into the complex circulation of discourse in public debate on policy issues (contingent repertoire)?

Like experts in public forums, students almost always took either a pro or con position, with rather little attempt to find common ground. They mainly reiterated the existing topoi of the debate, rather than introducing new arguments. They made arguments using scientific information largely by appropriating the arguments of the source in which the information appeared. The argument and the scientific information—evidence—makes a unit of argument. When they do not appropriate wholesale, they use scientific information to refute arguments and to support arguments. When students used information from a source that did not take a stand, they did so mainly to support an argument. But when they appropriated information from a source that did not take a stand, they also appear to delve more deeply into the arguments, getting at the complexity of the arguments.

The experts' use of scientific information within public policy debates seems to have served as a model for the students. The assumption on the part of many that the public will change its attitude toward GMOs through increased exposure to scientific information per se may bear further examination. Research on the uptake of scientific information within the complex networks of communication in which they typically receive that information may suggest ways to bring information (facts) from the empiricist repertoire of experimental articles into the wider circulation of information in the contingent repertoire of public discourse.

For example, there were few instances (models) in the sources of extended engagement between those with different views, where arguments could be developed in detail, under the rhetorical pressure of direct rhetorical engagement. It might be helpful to have forums for such engagement, and websites such as this one might be adapted to provide such a forum, even including live chats or threaded discussions that include experts who take various positions. Sites like this might allow experts and non-experts might engage issues more deeply and provide involvement not only of citizens with other citizens, and citizens with experts, but also experts with other experts. (Macoubrie, 2004).

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